THE
Saturday Magazine.

Nº 470. SUPPLEMENT, OCTOBER, 1839. PRICE ONE PENNY.

GLANCES AT RAILROAD TRAVELLING. No. I.

VILLAGE OF NEWTON, AND THE MANCHESTER AND LIVERPOOL RAILWAY.

In a recent Supplement, we presented the reader with a slight sketch of the principal modes of land travelling in England,—with one exception: an exception so important, and of such vast extent, that we could not think ourselves justified in devoting anything short of two or three complete Supplements for its consideration:—we allude to *Railroad Travelling*. We propose, therefore, to give a rapid view of the origin and progress of the railway system; and to conclude with an account of some of the most important railways now in action or in progress; as well in our own country as in other parts of the world.

When we hear the statement of a fact, which, if uttered ten years ago, would almost have been scouted as an untruth and an absurdity, that five and a half millions of pounds sterling will be the ultimate cost of the London and Birmingham Railway, we are at once tempted to ask, "What is the proposed advantage which renders such an outlay prudent?" We shall find that, whatever other advantages are gained, *diminution of friction* is the first and most prominent. The common roads are covered with gravel, broken stones, and other materials, which impede the motion of carriages to an extent which common observers are but little aware of, but which carriers, coach-proprietors, and other persons engaged in the conveyance of goods, have long known; and means have been from time to time devised for gradually improving the foundation on which the wheels press: the improvement consists mainly in making the roads *harder* and *smoother*.

It is to the collieries that we must look for the first introduction of railways, or bars of iron laid down in two parallel lines, for the reception of the wheels. The cost of conveying coals from the Newcastle pits to the sea was formerly very serious, because they were brought in small wagons on the common roads. But we find that so early as 1676, ingenuity had devised a means of saving expense in this respect, for in the *Life of the Lord Keeper North* we are told, "The manner of the carriage is by laying rails of timber from the colliery to the river, exactly straight and parallel; and bulky carts are made, with four rollers fitting those rails, whereby the carriage is so easy, that one horse will draw down four or five chaldrons of coals, and is an immense benefit to the coal-merchants." It is most probable that these wooden rails were simply attached to transverse pieces laid across the road. These wooden railways were thus described in 1765: "When the road has been traced, at six feet in breadth, and where the declivities are fixed, an excavation is made of the breadth of the said road, more or less deep, according as the levelling of the ground requires. There are afterwards arranged, along the whole breadth of this excavation, pieces of oak wood of the thickness of four, five, six, and even eight inches square: these are placed across, and at the distance of two or three feet from each other; these pieces need only be squared at their extremities; and upon these are fixed other pieces of wood, well squared and sawed, of about six or seven inches breadth, by five in depth, with pegs of wood: these pieces are placed on each side of the road, along its whole length: they are commonly placed at four feet distance from each other, which forms the interior breadth of the road."

By this wooden rail, the wheels of the carriages were freed from the friction of the gravel or earthy soil, and a great increase of speed and decrease of horse-labour is the result. But the rails were found to wear away very quickly; this led to the plan of laying a second rail on the top of the one first formed, by which a much longer duration of the rail could be calculated on. A horse could draw, in a wagon on a common road, 17 cwt. of coals; while on these wooden railroads, imperfect as they were, a horse could easily draw 42 cwt.

For many years nothing further was attempted in the railway system: the collieries were the only places where they were employed; and canals were then the favourite mode of conveying merchandize from one part of England to another.

It appears to have been about the year 1768 that the idea of employing cast-iron rails instead of wood was first acted on; for it was in the preceding year that we have the first evidence of the making of such rails at the iron works in Colebrook-dale. In 1776, iron rails were laid down upon the Duke of Norfolk's colliery, near Sheffield: these rails were cast in pieces about six feet long, and laid down upon wooden bearers or "sleepers," similar to those used with the wooden rails.

The next improvement was one of a marked and decided character:—it was, the substitution of stone supports for wooden ones. The plan of laying down wooden sleepers across the road begun gradually to be abandoned: and instead of them, stout solid stone blocks were laid down at the joinings of the several pieces of the rail,—one block to each joint. By this improvement it is evident that the bearings or supports for the rails were likely to be more lasting than those which were made of wood. This improvement was introduced about 1797.

This was, then, the state of railroads, or as they were then called *tram*-roads, at the commencement of the present century. They became gradually adopted to a great extent at the Welsh collieries. In 1791, there was scarcely a single railway in South Wales; but by the year 1811, there were no less than 150 miles of railway in Monmouthshire, Glamorganshire, and Caermarthenshire; and at the present time they amount to between three and four hundred miles. In these cases the wagons and wheels were extremely small. As an instance of the railways of those days, we will take that at the Penrhyn slate works, commenced in 1800, and finished in 1801. It was six miles and a quarter in length. Twenty-four small wagons, each containing one ton, were drawn by two horses (one stage) six times a day; which is 144 tons per day. Ten horses, by the use of this railway, drew as much as four hundred had been accustomed to draw on the common roads.

In 1803, a Mr. Woodhouse proposed that common roads, and even streets, should derive the advantages of the railroad system, by having concave iron rails laid down, protected, by a course of stone on each side, from being covered with gravel, earth, &c. This plan has, we believe, never been adopted so far as the busy streets of a town are concerned, but an approach towards it has been made in the Commercial Road, and in Friday Street, London, by laying down courses of granite stones for the wheels of heavy vehicles to roll upon.

It would be altogether beyond our limits were we to attempt to describe the progressive improvements in the form and manufacture of the rails,—in the bearings on which they are placed,—and in the mode of joining them end to end, so as to form a continuous and smooth surface. We can only here allude to the adoption of wrought-iron rails instead of cast-iron. These are formed by passing bars of iron, when red-hot, through rollers with indentations or grooves in their surfaces corresponding to the intended shape of the rails; and are generally from twelve to fifteen feet in length.

But we have now to advert to other and almost equally important points of the subject. We have said that the adoption of wooden or iron rails was for the purpose of lessening the amount of friction experienced by vehicles passing along roads. The next subject of attention is, whether these rails shall be laid down on a common road, used for the purpose of general traffic, or whether it be necessary to construct a new road for the purpose. Let us take the London and Birmingham road as an example to which to refer our reasoning. The old coach road resembles most other roads in being full of turns, windings and angles; and also in traversing hills and dales,—sometimes descending and at others ascending. Both of these circumstances greatly retard the progress of a vehicle moving along such a road, and increase the danger of overturning, &c. Therefore any arrangement by which the road could be made straighter and more level, would be a direct benefit in many ways.

It is, however, scarcely possible to estimate this part of the question in its proper light, without making reference to the means by which vehicles are drawn along the roads, whether by animal or steam power. We shall, therefore, proceed to that very important part of our subject.

The *horse* is the animal employed, under common circumstances, to draw our vehicles. The great power which this noble animal possesses, the facility with which he is taught, and the docility which he displays, strongly qualify him for this duty. Not only our vehicles on land, but also our barges on canals, are drawn by horses (for we may consider a canal to be a perfectly level liquid railroad); and it is doubtful whether any other animal would possess so many advantages and qualifications in this respect.

But still, animal power has its limit. We know that the human muscles will not bear beyond a certain amount of exertion; and the carrier or the coachman knows how far he ought to tax the strength of his horse; and, therefore, if an increased speed is to be attained, or an increased weight to be borne, an addition must be made in the number of horses employed. There are various different ways of estimating the strength of the horse: that one adopted by Mr. Smeaton was, that a horse could draw 200 pounds for eight hours a day, at 2½ miles per hour. But whether or not this statement be strictly received, one thing is certain, that even with a small load, a horse cannot exceed a certain amount of speed without being injured; our mails have rarely exceeded ten miles an hour, even with all the improvements applied to them.

The important question arises, therefore,—to what other source are we to look for a moving power? The magical effects (for they are almost magical,) of the *steam-engine*, and especially its application to navigation, naturally induce us to look to that as the means of obtaining a new moving power; and the same tendency which we now have to look to that source, as to a gigantic friend, was seen in some of the earlier promoters of the steam engine, even before its immense power was one-tenth part developed. The history of steam locomotion requires that its application to common roads should be spoken of before the application to railroads we will, therefore, proceed at once to that subject.

For a long period after the invention of the steam-engine its use was almost solely confined to drawing up water, and other similar operations; but it remained for James Watt to give it a power which (if it were not too bold) we would call illimitable, by giving it a rotatory power, as well as a longitudinal one. This rotatory power was applied to propelling machinery of all descriptions; and it is not surprising that the idea should have occurred to ingenious men, that as the motion of a carriage depends on the rotation of a wheel, it might be possible to use a steam-engine to bring about that rotation. Watt says:—

"My attention was first directed, in the year 1759, to the subject of steam-engines, by the late Dr. Robison, then a student in the University of Glasgow, and nearly of my own age. He, at that time, threw out an idea of applying the power of the steam-engine to the moving of wheel-carriages, and to other purposes; but the scheme was soon abandoned on his going abroad."

Twenty-five years afterwards, when Watt's mind had been deeply imbued with the subject, he included in one of his patents a mode of applying the steam-engine to the moving of wheel-carriages.

It is not, however, till 1802 that we meet with anything on this subject that need detain us here. In that year, Messrs. Trevithick and Vivian took out a patent for the first locomotive steam-engine. Watt's engines had acted by the power of low-pressure steam; but the new projectors employed the power of high-pressure steam, which, by not requiring the condensing apparatus, could be included in a smaller space. These patentees, indeed, made some admirable improvements in the steam-engine itself,—a locomotive carriage being only one of the purposes to which it was applicable. The carriage which they made was, in form, very much like a stage-coach, and the manner in which the steam-engine was combined with the machinery necessary for the motion of the carriage, (though too intricate to be described here) was admirable for its ingenuity. This carriage was frequently seen driving about in some of the waste grounds in the neighbourhood of London.

In 1811, a patent was taken out by Mr. Blenkinsop, for a steam-carriage to be used for the conveyance of coals and other commodities along a common road. On one side of the road was laid down a rail with indentations along its whole extent; into which worked the teeth of a wheel attached to a steam-carriage: the action of the steam caused the wheel to revolve, the teeth of which, by catching in the cogs of the rail, propelled the carriage. This carriage was capable of drawing twenty-seven wagons, weighing ninety-four tons, on a dead level, at $3\frac{1}{2}$ miles per hour; and when lightly loaded, it travelled ten miles an hour.

In the following year, another engine, made by Messrs. Chapman, drew after it eighteen loaded coal-wagons, weighing 54 tons, up a gentle ascent of forty-six feet in a mile, at the rate of ten miles an hour.

The next contrivance was one by Mr. Brunton, in which the carriage was provided with two appendages which were intended to act somewhat on the principle of the hinder legs of a horse in walking: the invention, however, did not ultimately succeed.

In 1816, Messrs. Stephenson and Losh made several great improvements in locomotive engines, as well as in the form of the rails of a railway in which they were to be employed. Steam-carriages of their construction have been at use in the Killingsworth colliery near Newcastle, and at Hetton colliery on the Wear.

From this period, newly patented improvements for steam locomotive engines for common roads increased so rapidly, that it is quite impossible for us even to mention them all in this brief sketch; but, fortunately, it is not necessary to do so, since they one by one fell to the ground, for some cause or other. There are only a few of them which we shall deem it necessary to mention.

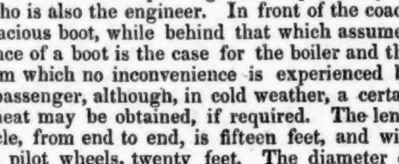
Mr. Gurney's steam-carriage, which was first used in 1827, is thus described in a journal of the time:—

"The carriage is constructed for accommodating six inside and fifteen outside passengers, independently of the guide, who is also the engineer. In front of the coach is a very capacious boot, while behind that which assumes the appearance of a boot is the case for the boiler and the furnace, from which no inconvenience is experienced by the outside passenger, although, in cold weather, a certain degree of heat may be obtained, if required. The length of the vehicle, from end to end, is fifteen feet, and with the pole and pilot wheels, twenty feet. The diameter of the hind wheels is five feet; of the front wheels three feet nine inches; and of the pilot wheels, three feet. There is a treble perch, by which the machinery is supported, and beneath which two propellers, in going up a hill, may be set in motion, somewhat similar to the action of a horse's legs, under similar circumstances, which assist in forcing the carriage to the summit. The total weight of the carriage and all its apparatus is estimated at a ton and a half, and its wear and tear of the road, as compared with a carriage drawn by four horses, is as one to six."

The last name that we can allow ourselves to allude to on this part of the subject is Mr. Hancock, whose locomotive carriages for common roads have been more successful than any that preceded them, although, from various causes, they have not maintained a permanent stand.

Mr. Hancock has, at different times, built several steam locomotives, which he has called, the Experimental Carriage, the Infant, the Era, the Enterprise, the Autopsy, the Erin, the German Drag, the Irish Drag, the Gig, and the Automaton,—the last of which is the one represented in the annexed cut, fig. 2.

Fig. 2.



HANCOCK'S AUTOMATON.

The Experimental Carriage made many trips in the neighbourhood of London; but it was in the year 1831, and with that carriage which he called the Infant, that the first attempt was made to ply a steam locomotive engine for hire, on common roads. The carriage in question plied between London and Stratford: every eight miles the driver took in water and coke: the average time of getting up the steam was about twenty minutes, and about a bushel of coke was used for that purpose at starting: the fore part of the vehicle was for passengers, and the hinder for machinery. In October, 1832, this carriage went to Brighton, with a load of 11 passengers.

The other carriages which we have mentioned were made by Mr. Hancock, either on private speculation, or as orders; and although their outward appearance differed considerably, the principle on which they were constructed was nearly identical. The average working speed of the carriages was from 10 to 12 miles an hour, and the cost of fuel about two pence halfpenny per mile.

But scientific difficulties have not been the only ones which the projectors of steam-carriages on common roads have had to contend against: excessive tolls demanded by the turnpike trusts, the opposition of interested parties, and the prejudices of the public generally, threw many embarrassments in the way of the adoption of these inventions.

In order that something like fair play should be afforded to his carriage, Mr. Gurney petitioned Parliament for its aid, upon which a committee was appointed to investigate the matter, and a very favourable report resulted, which concluded with the following summary:—

"Sufficient evidence has been adduced to convince your committee,—1. That carriages can be propelled by steam on common roads, at an average rate of ten miles an hour. 2. That at this rate they have conveyed upwards of fourteen passengers. 3. That their weight, including engines, fuel, water, and attendants, may be under three tons. 4. That they can ascend and descend hills of considerable inclination with facility and safety. 5. That they are perfectly safe for passengers. 6. That they are not (or need not be, if properly constructed) nuisances to the public. 7. That they will become a speedier and cheaper mode of conveyance than carriages drawn by horses. 8. That as they admit of greater width of tire than other carriages, and as the roads are not acted on so injuriously as by the feet of horses in common draught, such carriages will cause less wear of roads, than coaches drawn by horses. 9. That rates of toll have been imposed on steam-carriages, which would prohibit their being used, on several lines of road, were such charges permitted to remain unaltered."

The principal obstacles to the introduction of locomotive carriages on common roads, were considered to be the weight of these carriages themselves, and the mode of propulsion, which no common road would be able to bear for any length of time, without great injury. In the above report the committee state that, however strong their conviction may be of the comparatively small injury which properly constructed steam-carriages will do to the roads, yet this conviction is founded more on theory, and perhaps what may be considered as interested evidence, than practical experience. They therefore recommend that the House should not make, at that time, any permanent regulations in favour of steam. The experience of a few years would enable the Legislature to form a more correct judgment of the effect of steam-carriages on common roads. They therefore recommend that the tolls imposed on steam-carriages by local acts, where they shall be unfavourable to steam, be suspended during three years, and that, in lieu thereof, the trustees shall be permitted to charge toll, according to a rate agreed on by the committee.

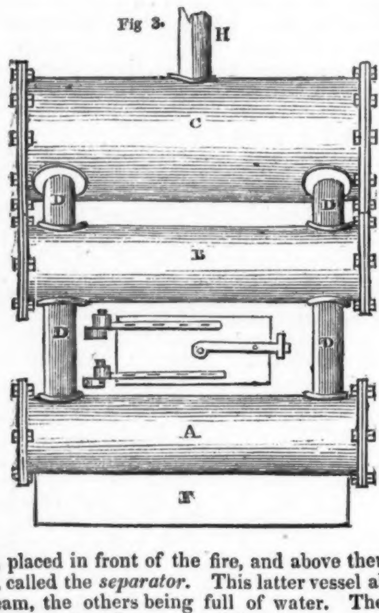
It was not anticipated by the committee that steam would be used as a propelling power on common roads for heavy wagons. It seemed to be the general opinion of witnesses that in proportion as the velocity of travelling by steam on common roads is diminished, the advantages of steam over horse-power are lost. The efficiency of horses in draught is rapidly diminished as their speed is increased; while, on the contrary, the weight which could be carried or propelled at any great velocity by steam, could not be more cheaply conveyed, were the speed decreased to that of the slowest wagon. Indeed, Mr. Gurney considers that under four miles per hour horses can be used in draught more economically than steam. From other parts of this report it appears that the greatest speed obtained by Mr. Ogle's carriage amounted to between thirty-two and thirty-five miles per hour; that it has attained sixteen and a half miles an hour on a slope rising one in six; that thirty-six persons have been in one carriage; and that it has drawn five times its own weight at from five to six miles an hour.

Steam-carriages for common roads have been made by Mr. Hancock and Mr. Gurney, exactly resembling in shape

an omnibus, a stage-coach, a britschka, and even a gig. The various points of difference between these vehicles, and the modes in which the different parts of the engine are connected with the wheels, the body of the carriage, &c., we cannot here enter upon; but we may perhaps direct a few moments' attention to the different modes in which Mr. Hancock and Mr. Gurney constructed the *boilers* of their engines. Much of the efficacy of a steam-engine, whatever may be the purpose to which it is applied, depends on the form and strength of the boiler, and its connexion with the fire-place.

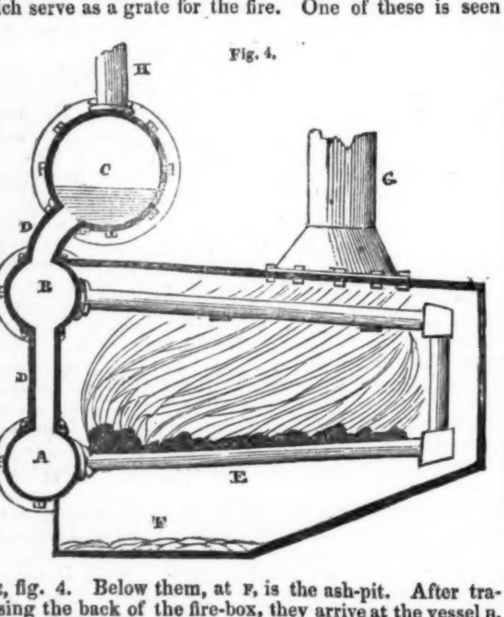
In Mr. Gurney's locomotive carriage, the bars of the grate are made hollow, and contain water. The construction of his boiler is shown in the following side and front views of it. It consists of two cylindrical vessels, A and B, figs.

Fig 3.



3 and 4, placed in front of the fire, and above them is the vessel C, called the *separator*. This latter vessel alone contains steam, the others being full of water. These three vessels communicate by means of the passages D D D D, and from the back of the lower vessel A proceed twelve tubes, which serve as a grate for the fire. One of these is seen

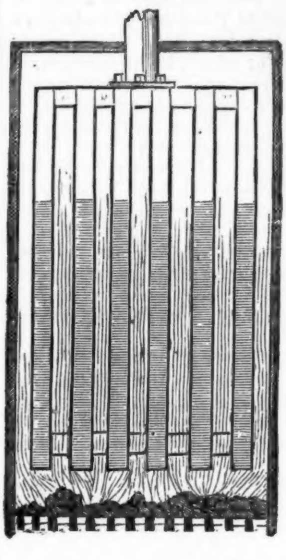
Fig. 4.



at E, fig. 4. Below them, at F, is the ash-pit. After traversing the back of the fire-box, they arrive at the vessel B, as seen in the side-view. The flame and smoke play round and between these tubes, and vaporize very rapidly the water in them. The steam, as it is formed, passes up into the separator C, and its place is supplied by cold water, descending through the passages D D. Thus a very quick circulation is regularly kept up. The chimney is at G, and the opening of the main steam-pipe at H.

In the boiler of Mr. Hancock's carriage, the water is contained between a number of upright plates of iron, as in the annexed lateral view, fig. 5. The water is thus distributed into thin sheets, between which the flame and smoke pass up from the fire below, to the chimney. The plates are connected together by tubes at the bottom and top, the former for the water, and the latter for the steam.

Fig. 5.



We have thought it necessary to give these few details respecting the use of steam locomotives on common roads, previous to speaking of their introduction on railways: on another occasion we propose to enter into particulars to show the manner in which the steam-engine is made available for the purpose of locomotion; our present object being rather to supply a brief history of railways in general than to describe minutely their details.

We may here notice, before speaking of the application of steam power to railways, that at many of the collieries, the wagons had been moved simply by the force of gravity. We have said that in most cases the road descends from a mine to a sea-port: consequently, when a rail was laid down on such a road, a loaded wagon would descend from its own weight, and would even require a counteracting weight to prevent it from descending too rapidly. Now it occurred to some persons that this counteracting weight might consist of the empty wagons, by having a rope or chain passing round a system of pulleys at the top of the inclined plane, so that as the loaded wagons descended by their own weight, the empty wagons were drawn upwards. This mode of proceeding dispensed with horse power, and was very much used, and probably still is, at some of the collieries.

But this kind of moving power is obviously inefficient on level roads, since the force of gravity cannot be brought into requisition. This objection, however, was of no great moment up to the year 1825; for, previous to that time, railways had been confined to the mining districts. It was in that year that the principle of railways was applied to the practical purposes of general conveyance. The previously existing railways were, to use the words of a recent writer, "isolated and private undertakings, confined to the mining districts; and therefore, very few persons had an opportunity of witnessing their operations. To the many, this subject was as yet a dark shadow in the womb of futurity. But from out the midst of this darkness, a new era was ushered to the wondering world. It was the birth-struggle of a giant power, destined ere long to bear down, like the rushing of a mighty torrent, all existing barriers, and give a direction, hitherto unknown, to the leading features of our social institutions; to annihilate,—or, at least, immeasurably extend,—the bounds of time and space; to convert our hills and our valleys into level plains; to throw up towering mountains, and scoop out dread deeps for himself from the very bowels of the earth."

The railway to which we have alluded was the Stockton and Darlington, the first for which an Act of Parliament was obtained, and which was opened in September, 1825. This line is but short, and is situated in the southern part of the county of Durham. The importance to be attached to this railway is on the ground, that it was the first one applied to the purposes of public conveyance, and not to the importance of the towns which it connects. We shall not therefore dwell on the details of its construction, but proceed to notice, at tolerable fulness, a railway which has been and always will be, of immense importance, both in a commercial and in an engineering point of view:—we mean the Liverpool and Manchester.

These two great towns stand in a remarkable and closely-linked relation to each other. The staple wealth of Manchester consists in the cotton manufacture which is carried on there; while Liverpool is the port at which the raw cot-

ton, to be worked up at Manchester, is landed from foreign countries, and from whence the manufactured goods are again exported: Liverpool is, therefore, at once the vein and the artery connecting Manchester with foreign nations. The consequence of this has been, that the traffic between those two towns has been immense; and it is natural to suppose that any and every means of facilitating the com munication from one to the other would be eagerly attended to. Consequently, when canal navigation became prevalent in England, that mode of transit was not lost sight of by the merchants of Liverpool and the manufacturers of Manchester. For a number of years the greater part of the merchandise was conveyed from one town to the other either by the Mersey and Irwell navigation, or by the Duke of Bridgewater's canal. But from the deficiency of water in Summer, the barges could not carry their usual freights; and from the operation of frost in Winter, the canal was frequently for weeks unnavigable. It is not, therefore, surprising that the efficacy of railways should have become a question for serious consideration.

In 1822, Mr. James, a London engineer, suggested the propriety of constructing a railway, such as had been found so advantageous in the collieries. This plan met with a good deal of attention; and in 1824, a Mr. Sandars published a pamphlet in recommendation of it. In this pamphlet he says,—

"Notwithstanding all the accommodation the canals can offer, the delays are such, that the spinners and dealers are daily obliged to cart cotton on the public high road, a distance of thirty-six miles, for which they pay four times the price which would be charged by the railroad, and they are three times as long in getting it to hand. The same observation applies to manufactured goods, which are sent by land carriage daily, and for which the rate paid is five times that which they would be subject to by the railroad. This enormous sacrifice is made for two reasons:—sometimes because conveyance by water cannot be promptly obtained, but more frequently because speed and certainty, as to delivery, are of the first importance."

One hundred and fifty merchants, who assented to the truth of these statements, set about establishing a company; and went to view the progress of the railroad then building from Stockton to Darlington. The result was so favourable, that proceedings were immediately set on foot: a permanent committee was appointed, and in October, 1824, a prospectus was issued. The estimated expense was 400,000*l.*; and the probable charge for carriage of goods was stated at ten shillings per ton,—two-thirds of the sum demanded by the canal companies.

An Act of Parliament being necessary to carry out the objects of the company, a portion of the committee went to London, in February, 1825, for the purpose of conducting the measure through Parliament. The opposition to it was very strong:—the proprietors of the Bridgewater canal, the Leeds and Liverpool canal, and the Mersey and Irwell navigation, together with some of the landed proprietors through whose estates the railway would pass, strenuously opposed it; some on the plea that it would interfere with their interests, others because it would destroy the beauty of their estates. The result was, that the bill was lost by a majority of one.

In the following year some improvements were made in the line of road chosen by the engineers,—some proposals were made, tending to soften the hostility of the opposing parties,—and another bill was brought in. The third reading was carried, in the House of Commons, by a majority of eighty-eight to forty-one, and in the Lords without a division. Thus did the company at last obtain their act, after 70,000*l.* had been spent in parliamentary proceedings.

On the 29th of May, 1826, the first general meeting of the company was held, and Mr. G. Stephenson appointed engineer of the company, having filled the same office for the Stockton and Darlington railway. Operations were commenced on Chat Moss, a district which had been the subject of much discussion in and out of Parliament. The moss consists of a huge bog, in some places thirty feet deep, and consisting of soft and pulpy matter in such a fluid state, that an iron rod would sink through it by its own weight.

To carry a road over this bog was deemed such an impracticable scheme, that even a civil-engineer denounced it, and afforded an instance of incautious prejudgment,—as the following extract from the parliamentary proceedings will show:—

Question. Tell us whether, in your judgment, a railroad can be safely made over Chat moss, without going to the bottom of the bog?
Answer. I say *certainly not.*
Q. Will it be necessary, therefore, in making a permanent railroad, to take out the whole of the moss to the bottom, along the whole line of road?
A. Undoubtedly.
Q. Will that make it necessary to cut down the thirty-three or thirty-four feet of which you have been speaking?
A. Yes.
Q. And afterwards to fill it up with other soil?
A. To such a height as the railway is to be carried; other soil mixed with a portion of the moss.
Q. But suppose they were to work upon this stuff, could they get their carriages to the place?
A. No carriage can stand on the moss short of the bottom.
Q. What would they do to make it stand,—laying planks or something of that sort?
A. Nothing would support it.
Q. So that if you could carry a railroad over this fluid stuff, if you could do it, it would still take a great number of men, and a great sum of money. Could it be done, in your opinion, for £6000?
A. I should say £200,000 would not get through it.
Q. My learned friend wishes to know what it would cost to lay it with diamonds?

Such a witness may well have been surprised, perhaps mortified, to see, a few years afterwards, a fine line of railroad thrown over the very bog which he declared to be impassable;—to see carriages going over it *without going to the bottom*,—carriages laden with tons of merchandize; and, instead of common diamonds, forming the pavement, to see "*black diamonds*" whirling over it to feed the furnaces of thousands of factories, which this fine road benefits:—and to reflect that the road, which he had declared would cost more than 200,000*l.*, actually cost, from the first draining of the bog, to the subsequent completion of the line over its surface, no more than 30,000*l.*

But to return. On this bog were placed hurdles of brushwood and heather, and on them were laid the wooden sleepers which were to support the rail. It is supposed there are as much as sixty million tons of decomposed vegetable matter forming the bog; and over this the railway had to pass for a distance of five miles. At the eastern part of the bog the surface was too low for the purpose of the railway, and it had to be raised by an embankment, half a mile in length, and twenty feet high. Some idea of the semi-fluid state of the bog may be formed from the circumstance, that the embankment which was raised, pressed down the original surface of the bog, and many thousand cubic yards of embankment gradually and silently disappeared by sinking into the bog. But the engineer persevered, and added more and more solid material, until the substratum became firm and secure, and no more sinking ensued.

While this was going on, several other parts of the railway were also in progress. Part of the plan was a tunnel under the greater part of the town of Liverpool. The first shaft of this tunnel was opened in September, 1826, and the horizontal digging commenced. This was a task of great difficulty; for in some parts the substance excavated was a soft blue shale, with abundance of water; and in other parts a wet sand presented itself, requiring no slight labour and contrivance to support, till the roof of masonry was erected. At one part, when working at thirty feet below the surface of the ground, the whole superincumbent mass of moss-earth and sand fell in. This disaster made the miners rather fearful, and it was with difficulty they could be persuaded to proceed with their work. Other parts of the tunnel were cut through a fine red sandstone, which was so firm and secure that it forms the roof of the tunnel, no other masonry being required. There were eight shafts, or vertical openings, descending from the ground to the tunnel, and the miners dug from one shaft to another, by making lateral excavations which formed the tunnel.

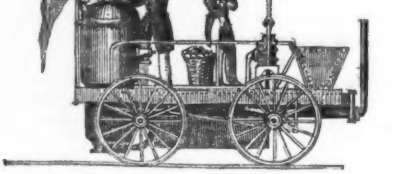
By the month of January, 1827, the works were in progress along the whole line; and during the years 1828 and 1829 bridges, embankments, and all the various portions of the undertaking, were in active progress. In the Darlington railway there was only one pair of rails laid down; so that if two carriages were going in opposite directions, it would be necessary that one should go a little out of the direct line, in order to allow the other to pass. This was effected by having extra portions of railway, called *sidings*, placed at intervals along the line. But where such great traffic is carried on as between Liverpool and Manchester, it was foreseen that great inconvenience and loss of time would result from such an arrangement. It was therefore resolved to have a double pair of rails for the whole distance:

one pair for carriages going in one direction, and the other for those moving in the opposite direction.

When the railway was first set on foot, it was not determined what kind of moving power should be used, whether horses, fixed engines, or locomotive engines:—this confirms our previous remark, that the diminution of friction is the most prominent benefit derived from a railway. While the railway was in progress the subject of motive power underwent discussion. It was soon decided that horse power should be rejected as least eligible; and it then became a subject of inquiry whether fixed engines or locomotive engines should be employed. The directors were nearly equally divided in opinion as to which of these two modes should be adopted; *i. e.*, whether to have a stationary steam engine, which should draw vehicles along by means of a rope or chain; or whether to make the engines themselves move, and draw the vehicles after them. In order to decide this point, it was deemed desirable to bring competition to their aid, by offering a premium to the inventor or owner of the engine which should best perform certain stipulated tasks. On the 25th of April, 1829, the directors offered 500*l.* premium for this object. Among the stipulations were,—that the engine should produce no smoke; that the pressure of the steam should be limited to fifty pounds on the square inch; that the engine should draw at least three times its own weight, at the rate of not less than three miles an hour; that it should be supported on springs; that it should not exceed the height of 15 feet,—and that the price of the engine should not exceed 550*l.*

On the 6th of October, the trial of skill took place. The engines competing were,—the Rocket, by Stephenson, the Novelty, by Braithwaite and Ericson, the Sans Pareil, by Hackworth, and the Perseverance, by Burstall. The load attached to each engine was three times the weight of the engine itself. The utmost precautions were taken to let all the engines have an equally fair trial, and three engineers, unconnected with the competition, were chosen as judges. The engine first tried was the Rocket: its average rate of progress was about fourteen miles per hour, and its consumption of water 114 gallons, and of coke 217 lbs., in the same space of time. The next engine was the Sans Pareil, which, with the trains attached to it, weighed nineteen tons, two more than the Rocket. The average rate at which it moved was fifteen miles an hour, with a consumption of 150 gallons of water, and 692 lbs. of coke, in the same time; but during the experiment, some of the boiler work got out of order, and the engine could not complete the task assigned to it. The next engine tried was the Novelty: the weight of this engine and its load, in consequence of some improvement in the construction, was only 10¾ tons; but during its progress an accident happened to it, which occasioned a delay of two or three days. On the 14th the trial took place; but another accident induced the proprietors of the engine to withdraw from farther competition. This engine, *i. e.* the Novelty, which, without reference to the result of the competition, is considered a beautiful specimen of mechanical ingenuity, is represented in the annexed cut, fig. 6.

Fig. 6.



THE NOVELTY.

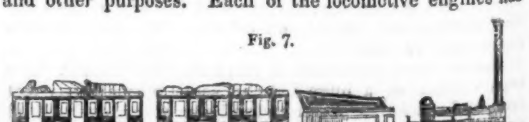
The last engine, the Perseverance, also met with an accident; and thus, singularly enough, three out of the four engines were put out of condition for showing their full powers. The result of the trial was, that the prize was awarded to Mr. Stephenson, inventor of the Rocket engine.

The engines having been fixed upon, the proceedings of the directors assumed a decided turn, and all was prepared, and by September 15th, 1830, the railway ready to be opened,—a ceremony which was performed in great state, commensurate with the national importance of the undertaking. The Duke of Wellington, Sir Robert Peel, Mr. Huskisson, and a number of other distinguished persons, were invited to be present. There were eight locomotive engines employed; viz., the Rocket, the Northumbrian, the Phœnix, the North Star, the Dart, the Comet, the Arrow, and the Meteor; all built by Messrs. Stephenson, and nearly on the same principle as the successful Rocket engine. The ceremony was splendid and completely satisfactory, so far as the efficacy of the railway and of the engines was concerned; but a cloud was thrown over the joy of the day by the accidental death of Mr. Huskisson, M.P. The carriage in which the Duke of Wellington, Mr. Huskisson, and other distinguished persons in the procession were seated, occupied, at one part of the trip, one of the lines of railway, in order that the occupants might see all the other engines and trains pass by. Several gentlemen had embraced the opportunity of alighting from the state-carriage, and were walking about on the road; among which number was Mr. Huskisson, who caught the eye of the Duke of Wellington. A recognition immediately followed, when the duke extended his hand, which Mr. Huskisson advanced to take. At this moment the Rocket came rapidly forward upon the other line, and a cry of danger was raised. Several gentlemen succeeded in regaining the state-carriage; but Mr. Huskisson, who was in a weak state of health, became flurried; and after making two attempts to cross the road upon which the Rocket was moving, ran back in great agitation to the side of the duke's carriage. White, the engineer, saw the unfortunate gentleman, as the engine approached, in a position of imminent danger, and immediately endeavoured to arrest its progress, but without success. Mr. Holmes, M. P., who had not been able to get into the carriage, stood next to Mr. Huskisson, and perceiving that he had altogether lost his presence of mind, called upon him "to be firm!" The space between the two lines of rails is just four feet; but the state car, being eight feet wide, extended two feet beyond the rail on which it moved, thus diminishing the space to two feet between its side and the rail on which the Rocket was moving. This engine also projected somewhat over the rail on which it ran; thus still further diminishing the standing-room to not more than a foot and a half, when the vehicles were side by side on the opposite rails. In addition to this, the door of the state car happened to be wide open; so that it was impossible for the Rocket to pass without striking it. Mr. Huskisson had just grasped hold of this door when he was warned of the approach of the Rocket. Mr. Littleton, M. P., had sprung into the state-car, and had just pulled in Prince Esterhazy, when he saw Mr. Huskisson, alarmed and agitated, grasping the door with a trembling convulsive hold. At this moment the Rocket struck the door, and Mr. Huskisson was thrown to the ground, across one of the rails of the line on which the engine was advancing, the wheels of which went over his leg and thigh, and fractured them in so dreadful a manner, as to produce death before the lapse of many hours.

We must now present a few details of the railway, as it is seen in its finished state, The rails are of rolled iron, two inches broad and one inch thick, in lengths of twenty-five feet each. These are firmly fitted together, and placed upon cast-iron chairs or pedestals, and the whole supported, at intervals of three feet, by stone blocks, twenty inches square and twelve deep. Into each of the blocks two holes are drilled, and filled up with oak plugs; and to these the pedestals bearing the rail are spiked down. On the embankments, and other places where the foundation may be expected to subside, additional firmness is secured by the introduction of oak sleepers. The whole length of the road is thirty-two miles; and posts are placed every quarter of a mile, to mark the distances.

There are stations and depôts at distances of a mile from one another along the road; and an admirable system of signals has been adopted, for the prevention of accidents, and other purposes. Each of the locomotive engines has

Fig. 7.



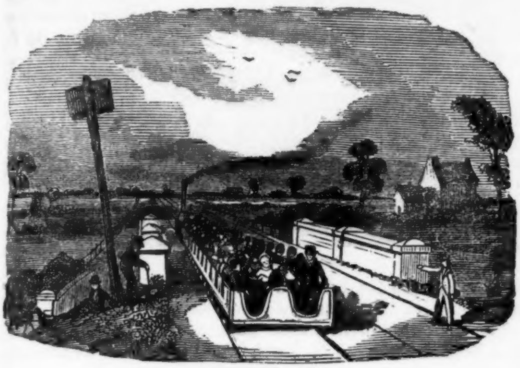
LOCOMOTIVE CARRIAGES.

immediately behind it a "tender," or light open vehicle, containing a supply of fuel and water, with the engineer and his assistant; and after the tender comes a train of from five to twenty carriages, according to circumstances.

These carriages are of different kinds,—some to carry passengers, others merchandize and luggage, and others live cattle.

Fig. 7 represents one of the engines, the tender belonging to it, and two close carriages attached. Fig. 8 will give an idea of some of the open carriages employed.

Fig. 8.



OPEN CARRIAGES.

The original estimate for the railway was, as we have said, 400,000*l.*; but the total outlay, including engines and carriages, was not far short of a million sterling.

In order to convey a better idea of the nature of the undertaking, we will conduct our readers in a trip from Manchester to Liverpool, pointing out the objects most worthy of notice on the way; but it will help more clearly to convey to the mind the nature of the road, if we previously say a few words respecting the inclined planes which occur during its length. At Liverpool the Docks are sixty-six feet below the level of Manchester, and at a short distance from Liverpool the land rises to no less than one hundred and sixty-nine feet above the Docks, or lowest end of the line, at Liverpool. Now all these circumstances make it necessary that skill must be shown in making the descent from the highest to the lowest points, as gradual and convenient as possible. There are a few short spaces perfectly level, and the remainder of the road is cut in inclined planes, of which the following is an enumeration:—

			With an inclination of
The tunnel from Wapping (Liverpool), to Edge Hill being an inclined plane, whose length is....	1970 yards	..	1 in 48
Level by cutting	1000 ,,		
Wavertree to Hayton	5½ miles	..	,, 1092
Wiston inclined plane	1½ ,,	..	,, 96
Rainhill level	1½ ,,		
Sutton inclined plane	1½ ,,	..	,, 96
Parr Moss to Sankey canal and viaduct	2½ ,,	..	,, 2640
Sankey viaduct to Bury lane	6½ ,,	..	,, 880
Chat Moss	5½ ,,	..	,, 1200
Baston, Eccles, & Munches levels .	4½		

On entering the railway station in Manchester, we ascend to the second floor of the building, and from thence emerge on the railway, so very elevated is it at the Manchester terminus. A handsome arch carries the railway across Water Street; and shortly afterwards we arrive at the river Irwell, over which it passes by a two-arched stone bridge, thirty feet above the level of the river. The natural level of the ground soon rises very rapidly, so that instead of passing *over* the natural roads, rivers, &c., the railroad for some distance passes *under* them, since an almost prefect level is one of the great desiderata in a railway. There is at this part a depôt for the reception of cattle from the surrounding country, intended to be conveyed along the railway. It consists of a large yard surrounded with sheds; pens are erected in front of the buildings; and the cattle vans, which are kept at a station a short distance from this spot, are brought near the pens, from which the cattle are driven into the vans.

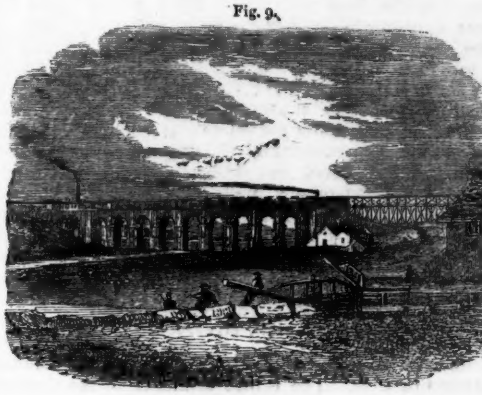
The railway is then carried along the side of a hill to the village of Eccles, and then over the Worsley canal by a viaduct of two arches, each twenty-five feet span. We next approach a continued embankment, about a mile in length, called Barton embankment: the land is too low at this part to allow of the railroad being carried over it, except by an elevated embankment. Several bridges have had to be built along this embankment.

This embankment conveys us to Chat Moss,—the mass of bog to which we have before alluded. There are about twelve square miles of this bog; and many attempts have been made to reclaim it, and bring it into cultivation. It is only since the construction of the railway, however, that they have shown symptoms of being ultimately successful. Moveable branch railways have been made in different directions, and little cottages have been erected and gardens formed, at those parts which are most solid: it seems most probable that capital and skill will ultimately bring all this immense bog into productive use.

Chat Moss is terminated by a little river, which the railway crosses by means of a bridge. It then passes along an embankment, called Broseley embankment, and immediately afterwards through a cutting or excavation, from which eight hundred thousand cubic yards of substance were dug, part of which was employed for the neighbouring embankment. Near this excavation, (which is called the Kenyon excavation,) two short railways join the principal one; one of which leads to Wigan, and the other to Bolton. We then come to the valley of the Newton, which requires a viaduct of four arches, of thirty feet span each. This village, with the viaduct, is represented in our frontispiece.

After passing the entrance to another short railway, leading to Warrington, we come to the vast Sankey viaduct, represented in fig. 9. The valley of the Sankey is a tract of land so low, that an extensive bridge, or viaduct, is required for the railroad to cross it. It consists of nine arches, of fifty feet span, and seventy feet above the surface of the ground. We then come to another bog, similar in character to Chat Moss, but of a smaller extent, which had to be solidified by immense embankments of earth. After passing under a beautiful stone bridge at St. Helen's, we reach the Sutton inclined plane. This is a perfectly straight line, one mile and a half in length, and presents an uniform rise of one foot in ninety-six. The summit is, therefore, eighty-two feet above the base, and an extra engine is kept there, to draw the trains up the inclined plane.

Fig. 9.



SANKEY VIADUCT.

This inclined plane terminates in a perfectly level excavation two miles in length; and we then arrive at a descending inclined plane almost exactly similar to that which the traveller had lately ascended. Now the object of these two inclined planes may be soon conceived:—had they not been formed, the intermediate excavation (the Rainhill level) must have been continued to the enormous extent of 82 feet lower, in order to gain the level of the road at either end. The Rainhill level is crossed by a beautiful bridge forming part of the Warrington road.

We then come to the Great Roby embankment and to the Olive Mount excavation, both works of immense labour, the materials dug from the latter being used for the former. The Great Roby embankment stretches across a valley of nearly two miles in width, and has an elevation, in many places, of more than forty feet above the natural surface. The lowest altitude is fifteen feet, and the breadth of the base varies from sixty to one hundred and thirty-five feet. "Mounted above the tops of trees, the traveller," to use the words of a recent writer, "looks around him over a wide expanse of country, in the full enjoyment of the fresh breeze from whatever quarter it may blow. There is a feeling of satisfaction, by no means common-place, in thus overcoming obstacles, surmounting difficulties, in making the high places low, and the rough places plain, and advancing in one straight and direct course to the end in view."

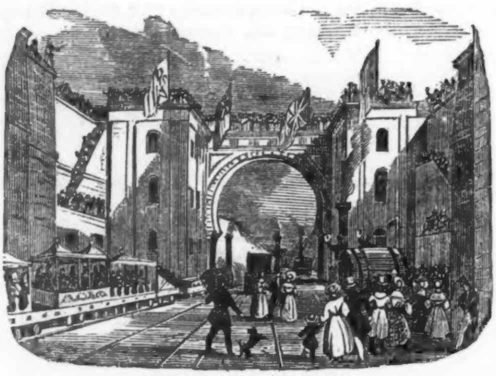
Olive Mount excavation, shown in fig. 12, is a striking example of "making high places low." It is a passage for

the railway effected by a cutting through a solid rock, seventy feet deep, about twenty feet wide, and nearly two miles in length. As Mr. Walker observes, when the excavated channel is viewed from above,—

" So diminutive a creeping creature does a man appear at the bottom of the chasm, that a spectator marvels that it is the work of human industry, and is lost in the calculation of the millions of blows with the pick-axe, the amount of human toil, and sinew and skill, that must have been exerted to remove so prodigious a mass of matter."

From the Olive Mount excavation, the whole remaining portion of the road is excavated likewise, but not to so great a depth,—varying from four to forty feet. This continues until we arrive at the grand entrance arch to Liverpool. This is a beautiful structure. It is a Moorish arch, elevated forty feet from the railway, and having a span of thirty-five feet; and at the sides of the arch, are buildings for containing two stationary engines for drawing the trains up the inclined tunnel. When we have proceeded through the Moorish arch, we find ourselves in a spacious area, dug out of the solid rock to a depth of forty feet below the natural surface of the ground. This area is perfectly level; is one hundred and fifty feet long, and seventy wide; and surrounded on all sides by embattled walls forty-six feet high. At the corners of the eastern side of the area are flights of steps leading to the ground above; and at the opposite corners are two handsome chimneys 100 feet high, belonging to the steam-engines stationed in the side buildings. Fig. 10 represents the Moorish arch, and the area to which we have just alluded: the moment of taking the drawing is at the occasion of the opening of the railway, when every accessible point was crowded with spectators.

Fig. 10.



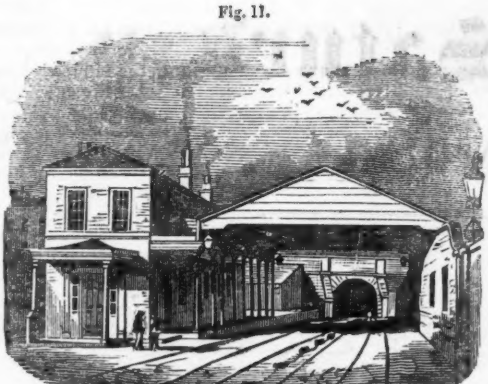
MOORISH ARCH, LIVERPOOL.

At the western side of the area are three arches leading to the three tunnels. The centre tunnel is for the conveyance of goods to the Wapping warehouses, Liverpool; the right-hand tunnel is for the conveyance of passengers to the station in Crown Street; and the tunnel on the left is for conveying coals. The right hand, or passengers' tunnel, is 290 yards in length, and ascends in a ratio of one yard in forty-eight; which gives a whole rise of eighteen feet. This tunnel is painted white and illuminated with gas.

But the great tunnel is the object which calls most for admiration. It is twenty feet in width and sixteen feet high, and gradually descends in a perfectly straight line for 1980 yards, with an inclination of one yard in forty-eight, so that the lower end of this straight line is 123 feet lower than the upper end. At the bottom of the descent, the tunnel curves to the left for about two hundred and seventy yards: making the whole length about one mile and a third. The tunnel is painted white, and illumined with gas lamps hanging from the roof. This tunnel passes under a considerable portion of the town of Liverpool, at a depth of from five to seventy feet beneath the surface of the ground, and emerges at the lower end near the water-side. The trains are drawn up this tunnel by an endless chain or rope, which is worked by the stationary engines at the upper end. Fig. 11 represents the entrance to the tunnel at Edge Hill.

We have thus presented a rapid view of this splendid undertaking; and we may make a few additional remarks respecting the traffic on it. The time occupied in travelling from Manchester to Liverpool is about an hour and twenty minutes. The gross sum received by the company for the carriage of goods and passengers, has amounted to from 200,000*l.* to 250,000*l.* per annum. The shareholders have,

Fig. 11.



EDGE HILL TUNNEL.

for some time past, received 10 per cent. dividend on their shares; and a 100*l.* share will sell for more than 200*l.*

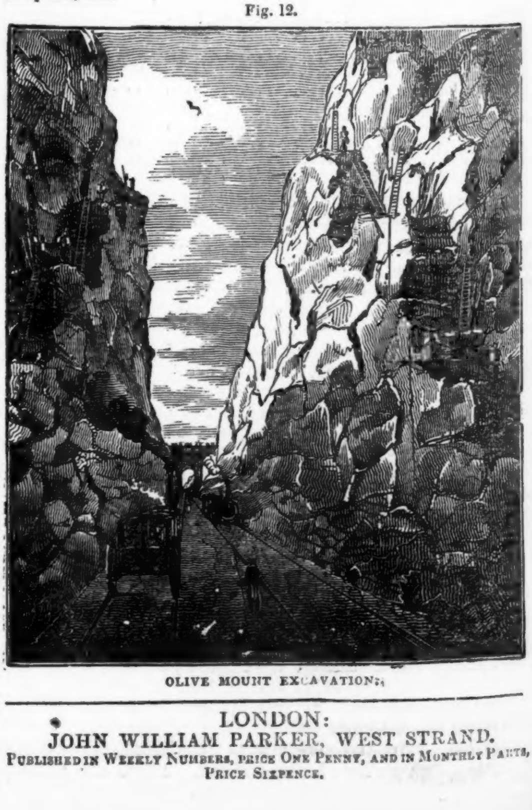
The passengers and merchandize conveyed on the railway from September, 1830, to June, 1836, amounted as follows:

YEAR.	MERCHANDIZE. *Tons.*	COAL. *Tons.*	PASSENGERS.
1830 (Sept. to Dec.)	1,433	2,630	71,951
1831	43,070	11,285	445,047
1832	159,443	69,396	356,945
1833	194,704	81,509	386,492
1834	210,736	99,337	436,637
1835	230,629	116,246	473,847
1836 (to June)	117,617	68,893	222,848
	1,023,120	449,296	2,393,767

These annual reports have since been discontinued.

We have deemed it desirable to dwell at considerable length on the details of the Liverpool and Manchester railway, because it may be considered as a type of all the subsequent undertakings, and as comprising instances of all the various difficulties which the engineers have to contend with. But the subject is too interesting in a commercial point of view for us to quit it here. We propose to devote another Supplement to a history and description of three or four of the most important railways set on foot since the opening of the Liverpool and Manchester:—such, for instance, as the London and Birmingham, the Great Western, the Manchester and Birmingham, the London and Southampton, &c.

Fig. 12.



OLIVE MOUNT EXCAVATION.

LONDON:
JOHN WILLIAM PARKER, WEST STRAND.
PUBLISHED IN WEEKLY NUMBERS, PRICE ONE PENNY, AND IN MONTHLY PARTS, PRICE SIXPENCE.